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TAPAS UPGRADE AND DEMONSTRATION FOR  
RESOURCE PLANNING AND MANAGEMENT

**Final Report**

**TAPAS UPGRADE AND DEMONSTRATION FOR  
RESOURCE PLANNING AND MANAGEMENT**

**(F.S. Research Agreement No. 28-K4-341)**

Prepared for:

Douglas G. Fox, Ph. D.  
Rocky Mountain Forest and Range Experiment Station  
240 West Prospect Street  
Fort Collins, Colorado 80526

By

Air Resource Specialists, Inc.  
634 South Mason Street  
Fort Collins, Colorado 80524

November, 1985

 **Air Resource  
Specialists, Inc.**

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EXPERIMENT STATION

**Environmental Consultants**

Air Quality, Monitoring,  
Modeling, & Analysis

Fort Collins, Colorado

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## 1.0 INTRODUCTION

The execution of this contract has been part of the ongoing effort by the Rocky Mountain Forest and Range Experiment Station to develop and enhance the Topographic Air Pollution Analysis System (TAPAS) (Childs and Marlatt, 1981; Dietrich, 1983; Fox, et. al., 1983; and Air Resource Specialists, Inc., 1984, and 1985), to meet the air resource management needs of the Federal Land Manager.

This contract had four primary objectives:

- 1) to upgrade the TAPAS system to include a refined Pollution Dispersion Potential in complex terrain;
- 2) to upgrade the TAPAS system by beginning the task of converting the TAPAS source code and implementing it on the Data General MV/8000 Computer System at the Rocky Mountain Forest and Range Experiment Station;
- 3) to demonstrate the TAPAS system for resource planning and management in Wyoming and Oregon;
- 4) to upgrade and refine the algorithms and code in the two-dimensional and three-dimensional wind field models in TAPAS;
- 5) to modify the TAPAS system to incorporate the NOS 2.4 operating system upgrade introduced by the Colorado State University Computer Center; and
- 6) to develop a documented set of procedures to access the CPS-1 contouring package installed on the Cyber 205 supercomputer at CSU.

In addition, as directed by the COTR, the following support for BLM, EPA, Los Alamos National Labs agency personnel, and university groups was provided within this contract:

- 1) air quality study assistance;
- 2) preparation of data and program tapes;
- 3) development of meteorological data bases; and
- 4) assistance in preparing TAPAS graphics demonstrations.

## **2.0 AIR POLLUTION DISPERSION POTENTIAL ANALYSIS**

### **2.1 Development of a Procedure for Calculating Pollution Dispersion Potential in Complex Terrain**

A significant enhancement to the Two-Dimensional Wind Field Model WINDS was the modification of the pollution dispersion potential algorithm. This upgrade will provide a more uniform index that is consistent between study areas and grid sizes. The calculation was incorporated in TAPAS and documented in two interim reports;

- 1) A Description of the Pollution Dispersion Potential Index of the TAPAS Two-Dimensional Winds Model - a Technical Note, for F.S. Research Contract No. 28-K4-341, 43 pages + plates, June 15, 1985.
- 2) A Description of the Pollution Dispersion Potential Index of the TAPAS Two-Dimensional Winds Model - Appendix C addendum to the TAPAS User's Guide, for F.S. Research Contract No. 28-K4-341, 23 pages, June 15, 1985.

### **2.2 Demonstrate the Dispersion Potential Procedure for the Sublette Air Basin of Southwestern Wyoming**

The pollution dispersion potential index (PPI) was demonstrated in two operational BLM resource management studies in the Sublette Air Basin of Southwestern Wyoming. The areas varied considerably in size and variety of topography. PPI values calculated earlier in the project were recalculated. Results of the investigation were prepared and delivered as follows:

- 1) computer printouts of detailed WINDS model runs;
- 2) eight velocity vector maps (originals and black line copies) at map compatible scale;
- 3) eight contoured maps of the old and new PPI (originals and black-line copies) at map compatible scale;
- 4) four contoured elevation maps at 100 and 200 meter contour interval for two base areas (originals and black-line copies) at map compatible scale;



- 5) three CITPUFF model plume plots with five sources at map compatible scale;
- 6) two CITPUFF model plume dynamics studies with plots at map compatible scale;
- 7) regional base maps at map compatible scale;
- 8) a report entitled:  
Air Quality Related Modeling Techniques Applicable to National Gas Resource Development in the Overthrust Belt - a Draft Interim Report, for F.S. Research Contract No. 28-K4-341, 68 pages, March 15, 1985.; and
- 9) a report entitled:  
Regional Risk Identification Analysis Applicable to Resource Development of H<sub>2</sub>S Contaminated Natural Gas Fields in Southwestern Wyoming, for F.S. Research Contract No. 28-K4-341, 49 pages + plates, July 15, 1985.



### 3.0 SMOKE MANAGEMENT DEMONSTRATION

As one of the tasks to demonstrate TAPAS within this contract, the TAPAS Three-dimensional Wind Field Model ATMOS-1 (Davis and Bunker, 1982) was used to evaluate its potential as a predictive tool in smoke management planning. The task involved computer modeling and field observations of a prescribed burn in Oregon (the burn observation was not made by Air Resource Personnel due to poor weather conditions, although travel to Oregon was made in preparation for the burn).

This task was used to develop a pre-burn analysis to estimate plume transport and dispersion under the range of conditions described by the fire prescription. In addition, a post-burn analysis of the modeling results, actual burn data, and post-burn simulation was performed. These results were presented in a report entitled:

A Smoke Management Application Test of the Topographic Air Pollution Analysis System Three-Dimensional Winds Model ATMOS-1, for F.S. Research Contract No. 28-K4-341, 33 pages, November, 1985.

#### 4.0 INSTALLATION OF SELECTED TAPAS MODULES ON DATA GENERAL EQUIPMENT

An effort is underway to convert portions of TAPAS for use on Data General computers at a Government installation. The initial thrust of this effort was to incorporate TAPAS into the IAMS system at BIFC for ease of access by government personnel. Travel to Boise, Idaho by Air Resource Specialists, Inc. personnel, the COTR and BLM personnel was made to discuss this implementation. However, incompatibilities between the IAMS approach and TAPAS requirements precluded this effort.

Subsequent meetings with the COTR and associated BLM personnel during the course of this contract have determined that TAPAS should be implemented on the Data General ECLIPSE MV/8000 computer at the Rocky Mountain Forest and Range Experiment Station in Fort Collins. This version of TAPAS will require moderate modifications to FORTRAN code, major modifications to the operating system driver routines, a potential major rewrite of the graphics modules, and a major rewrite of all user documentation. Several modules were converted as part of this contract which are outlined in Tables 4-1, 4-2, and 4-3. All of the converted programs and new utilities were thoroughly tested.

A summary of the installation of the Data General version to date including an interim users guide is included in a report entitled:

Progress Report and Interim User's Guide for the Data General ECLIPSE MV/8000 Version of TAPAS - a Progress Report and Interim User's Guide, for F.S. Research Contract No. 28-K4-341, 65 pages, June 15, 1985.

TABLE 4-1. Programs Included in the Data General Version of TAPAS.

TAPAS MODULE	CDC PROGRAM/ FUNCTION	DG PROGRAM/ FUNCTION
File Management	CREATEC	CREATE.F77
	ROWCOLC	ROWCOL.F77
	FILSUPC	Incorporated into TAPASDG Macro and file management programs
	TAPROC	Incorporated into TAPASDG Macro
	TAPLIBC	TAPLIB.F77
2-D WINDS	WINDSC	WINDS.F77 (includes new pollu- tion potential algo- rithm)
	WINDLBC	WINDLB.F77
	WINDSUPC	WINDSUP.F77 (modified to create control parameter files only)
	WINDS Configure	Incorporated into TAPASDG Macro
	WINDSETC	WINDSET.F77

**Table 4-2. UTIL.F77 Routines Developed for TAPASDG.**

ROUTINE	PURPOSE
PROMPT	Writes an 80 character prompt or question to the user's screen and reads user response
CREFIL	Creates new files for data storage. If named file exists, CREFIL assists the user in recovery by querying for overwrite or new file name.
OPENFIL	Opens an existing data file for data retrieval. If named file does not exist or other error occurs, OPENFIL assists in recovery.
CLOSFIL	Closes any files opened. If error occurs in closing, the routine aborts execution.
ERASE	Closes and deletes a file from the user's directory.
WEOF	Emulates the CDC FORTRAN function to write a multi-file partition. This routine uses an ASCII GS (group separator - hex 1D) character.
EOF	Emulates the CDC FORTRAN function to check for end-of-file in a multi-file file. This routine checks for an ASCII GS character (see WEOF above).



**TABLE 4-3. TAPASDG Macro Functions.**

MENU OPTION	FUNCTION
FILSUP	Places the user in the TAPAS File Supervisor Module.
WINDSMOD	Places the user in the TAPAS 2-D WINDS Module.
WINDCON	Executes WINDS configure and compilation.
WINDSUP	Executes WINDS control file supervisor.
WINDSET	Executes WINDSET program.
WINDS	Executes WINDS model.
DONE	Exits from WINDS module to the TAPAS Macro menu.
FILES	Executes a CLI FILESTATUS command for listing file directory contents.
SED	Executes the CLI system editor.
LIST	Executes the CLI TYPE command for listing the contents of a file to the user's screen.
PRINT	Executes the CLI QPRINT command to print the contents of a coded file on one of the RMFRES printers.
REN	Executes the CLI RENAME command to rename files in the user's directory.
DEL	Executes the CLI DELETE command to delete files from the user's directory.
DONE	Exits from the TAPAS Macro to the CLI command level.

## 5.0 ENHANCEMENT OF THE TWO-DIMENSIONAL AND THREE-DIMENSIONAL WIND FIELD MODELS

Efforts to improve and enhance the quality of the TAPAS models is a primary goal of the air resource managers who have developed TAPAS. This effort has lead to the involvement of Dr. D. G. Ross of the Centre for Applied Mathematical Modeling, Chisholm Institute of Technology, Melbourne, Australia. Dr. Ross and his associates have made significant inroads in the algorithms used in the TAPAS models, including the development of the CITPUFF model (Ross, et. al., 1983). Further development on the two and three-dimensional wind field models WINDS AND ATMOS-1 of TAPAS has continued as part of this contract. Dr. Ross delivered copies of the completed source code with test data in June of 1985 and assisted in installing interim versions of the models on the CSU Cyber computers. The ATMOS-1 Version 2.0 model has been included on the TAPAS archive tape (A0794) at CSU. Details of the modifications made at this phase of the upgrade and a preliminary user's guide are presented in a report entitled:

User's Guide to the Three-Dimensional Wind Field Simulation Module - Version 2.0 - a Preliminary Report and Interim User's Guide, for F.S. Research Contract No. 28-K4-341, 148 pages, June 15, 1985.

The modified version of WINDS called NEWINDS has not been included on the TAPAS archive tape at CSU since the modifications to the code have not yet been completed. A user's guide was completed to be used as preliminary testing documentation:

Modifications to WINDS by G. Ross - a Preliminary Documentation, for F.S. Research Contract No. 28-K4-341, 37 pages, May, 1985.

## **6.0 MODIFICATION OF TAPAS TO ACCOMODATE THE NOS 2.4 OPERATING SYSTEM UPGRADE**

In January, 1985 a new operating system was installed on the GOLD machine at CSU which required extensive modifications of the TAPAS system. This operating system upgrade required extensive modification to the interactive JCL portions of TAPAS as well as conversion of FORTRAN IV to FORTRAN 77. All code was successfully converted with the exception of the NCAR graphics programs. These programs are tied to library routines on the CSU system which the contractor does not have access to. In order to make the necessary changes, the cooperation of the CSU systems managers will be required and extensive programming on the part of the contractor. It is recommended that the present compiled NCAR graphics be used as long as possible and at that time, a new graphics system be incorporated into TAPAS.

Nine one-page addendums to the existing TAPAS User's Guide were prepared for F.S. Research Contract No. 28-K4-341 in February, 1985 to document the modifications to the system programs, JCL and user actions and delivered to the COTR for distribution to TAPAS users.

## **7.0 DEVELOP A DOCUMENTED SET OF PROCEDURES TO ACCESS THE CPS-1 GRIDDED CONTOURING PACKAGE**

The CPS-1 contouring package by RADIAN CORP. was acquired by the CSU Computer Center in 1984. It was determined that it would be an appropriate TAPAS enhancement to utilize this package. A procedure file was developed to provide the TAPAS user with interactive assistance in executing the CPS-1 software and data preparation. This new TAPAS module now allows the user to create a contour map from gridded data with numerous options for labeling and contouring methods. The module is documented in a new TAPAS user's guide which was delivered to the COTR for distribution to TAPAS users which is entitled:

User's Guide to the CPS-1 Gridded Contour Graphics Package, for F.S. Research Contract No. 28-K4-341, 38 pages, March, 1985.



## 8.0 TAPAS USER SUPPORT

In addition to the tasks defined in the Study Plan for contract 28-K4-341, the contractor provided support as requested by the COTR to various government and university groups related to operation and distribution of TAPAS software:

- 1) assistance was provided to S. Archer and R. Fisher in developing air quality data bases with TAPAS software in northwest Colorado;
- 2) assistance was provided to the COTR and A. Riebau in preparation of TAPAS demonstration graphics including a CITPUFF dynamics study and examples of NCAR and CPS-1/Visual 500 graphics;
- 3) TAPAS elevation data tapes and TAPAS source code were provided for university use;
- 4) TAPAS source code tapes were provided to EPA and Los Alamos National Labs; and
- 5) time lapse photography was provided for A. Riebau.

## 9.0 SUMMARY

Air Resource Specialists, Inc. the primary contractor for this project provided TAPAS upgrades involving new software, upgrades of existing software, and modifications of existing software required by operating system upgrades at CSU. The new software was developed for the existing Cyber version of TAPAS as well as a new version being developed for the Data General ECLIPSE MV/8000 at the Rocky Mountain Forest and Range Experiment Station.

Operational demonstrations of TAPAS software were implemented for projects in Wyoming and Oregon which utilize many of the TAPAS models and utilities. In addition, Air Resource Specialists, Inc. provided assistance to numerous TAPAS users for operation and acquisition of TAPAS programs and data.

Work completed during this contract has also been presented in monthly interim project reports presented to the COTR. A summary of the tasks completed by Air Resource Specialists, Inc. under contract F.S. Research Contract 28-K4-341 is presented in Table 9-1.

**TABLE 9-1. TAPAS Upgrade and Demonstration for Resource Planning and Management - Completed Tasks**

Date	Subtask
October-December	o H <sub>2</sub> S Pollution Potential Study of Southwest Wyoming
	o Prepared full size high quality maps for Southwest Wyoming Study
	o Assisted S. Archer - NW Colorado Pollution Potential
	o Travel to scheduled prescribed burn in Oregon
	o Investigate implemetnation of TAPAS on Agency computer
	o Developed new pollution potential algorithm
	o Determined modifications to CSU TAPAS due to operating system upgrade
January	o Recalculated PPI for SW Wyoming and NW Colorado
	o Puff Dynamics Study
	o Upgraded TAPAS to new operating system and FORTRAN 77
	o Developed new CPS-1 gridded contouring module
	o Prepared TAPAS Demonstration graphics and Puff dynamics for D. Fox
	o Prepared PPI for detailed area at Evanston, Wyoming
February	o Draft Interim report - Air Quality Related Modeling Techniques Related to Natural Gas Resource Development in the Overthrust Belt
	o Addendums for NOS 2.4 upgrade prepared
	o CPS-1 Gridded Contouring user's manual prepared
	o Traveled to BIFC for TAPAS/IAMS implementation conference
March-April	o Acquired data set for prescribed burn (JOULE 21-22)
	o Prepared magnetic tape with Terrain Data Management Module and RANELV data base for Los Alamos National Labs
	o Assisted in NW Colorado Air Quality Study for S. Archer
	o Prepared demonstration plot of Visual-500 Graphics terminal for A. Riebau
May-June	o Installed and tested G. Ross-modified versions of NEWINDS and ATMOS-1
	o Prepared time lapse photography for A. Riebau
	o Supported R. Fisher in development of meteorological computer data base for NW Colorado
	o Prepared TAPAS WINDS model appendix describing new Pollution Potential
	o Prepared documentation and user's guide for CPS-1 Gridded Contour Package
	o Prepared Technical Note describing new TAPAS WINDS PPI
	o Installed WINDS and necessary support modules on Data General ECLIPSE MV/8000

**TABLE 9-1. TAPAS Upgrade and Demonstration for Resource Planning and Management - Completed Tasks (continued)**

July-August	o	Completed air quality support document for the southwest Wyoming resource management plan
	o	Completed documentation and user's guide for NEWINDS and ATMOS-1 and installed code at CSU
	o	Prepared magnetic tape with new ATMOS-1 source code for EPA
	o	Investigated NCAR graphics possibilities to be included in TAPAS-DG
	o	Prepared documentation and interim user's guide for TAPASDG
September-October	o	Prepared report on test of ATMOS-1 as planning tool for prescribed burns
	o	Assisted A. Riebau and S. Archer with TAPAS operation
	o	Completed Final Report



## 10.0 REFERENCES

- Air Resource Specialists, Inc. 1984. Final Report - Interfacing TAPAS with IAMS for Land Management Needs. USDA. F. S. Research Contract No. 28-K3-292. Rocky Mountain Forest and Range Experiment Station.
- Childs, J. E. and W. E. Marlatt. 1981. Topographic air pollution analysis system -- Guide to system software. Final report of Cooperative Agreement 16-861-CA Between Colorado State University and Rocky Mountain Forest and Range Experiment Station. 2 volumes: 108 p. + 4 appendices, Ft. Collins, CO.
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